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PALEOECOLOGY OF PEATLANDS AT HUFF AND HAGER LAKES, IDAHO PANHANDLE NATIONAL FOREST: FY92 YEAR-END SUMMARY

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PALEOECOLOGY OF PEATLANDS AT HUFF AND HAGER LAKES, IDAHO PANHANDLE NATIONAL FOREST:

FY92 YEAR-END SUMMARY

by

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INTRODUCTION

Peatlands are generally defined as wetlands with waterlogged substrates and at least 30 cm of peat accumulation. Bursik (1990) recognized two types of peatlands in Idaho based on vascular floristic composition: (1) *Valley Peatlands*, which generally occur around lakes and ponds at relatively low elevations in major river valleys, from near Bonners Ferry, in the panhandle, to near Driggs, in eastern Idaho; and (2) *Subalpine Peatlands*, which are more common throughout the same portion of Idaho, but generally form along low-gradient, subalpine streams. Subalpine peatlands are generally characterized by plant species common throughout the western cordillera, while valley peatlands are characterized by numerous boreal species whose Idaho populations are disjunct by hundreds of miles from the main portion of their range in boreal regions of Canada.

The biodiversity value of Idaho's valley peatlands is high. Although wide-ranging across the state, the occurrence of valley peatlands is very rare on the landscape as a whole and they contain some of the highest concentrations of rare species found in Idaho. Approximately 12% of Idaho's rare vascular flora is more or less restricted to peatland habitats, as is one rare mammal. The narrow suite of environmental conditions that lead to the formation of peatlands create conditions suitable only for species specifically adapted to these sites.

Peatlands are an important terrestrial habitat worldwide where they cover an estimated one percent of ice-free continental land masses. As much as 15 percent of Canada is covered by peatlands where they are not only important from a biodiversity perspective, but also economically important from an industrial and energy perspective (in the form of peat mining). Globally, peatlands have long been looked at as worthless, forbidding land. Every effort was made to drain them for forestry or to mine them for peat fuels. Northern European countries with once immense peat reserves are now scrambling to preserve their last remaining tracts of pristine peatland habitat. Finland has drained more than half of its 25 million acres of peatlands for forestry. Only five percent of Ireland's 3 million acres of peatland remain untouched (Breining 1992). Although North American peatlands have fared far better, the continued threat of development exists, particularly if conventional sources of fuel and electricity generation become limiting or expensive.

Worldwide, peatlands exert a tremendous influence on the earth's climate. Methanogenic anaerobic bacteria inhabiting peat soils produce as much as 40 percent of the methane (an important "greenhouse gas") released into the atmosphere annually (Breining 1992). On the other hand, peatlands act as immense sinks of carbon dioxide, the most important greenhouse gas. In fact, it is estimated that peatlands store 15 to 20 percent of terrestrial carbon reserves, more than twice the amount in all living northern latitude forests (Breining 1992).

Idaho's peatlands also provide an important historical perspective through the plant fossils and volcanic ash preserved in their peat deposits. Peat contains a postglacial record of regional and on-site vegetation (in the form of pollen and plant macrofossils), which allows ecologists to reconstruct the regional vegetation patterns and climatic history, as well as the historical

development of the peatland itself. Peat deposits enable ecologists to address questions about landscape and community development and evolution in the context of centuries or millennia rather than over one or a few field seasons (Schoonmaker and Foster 1991). Models for ecosystem development and landscape evolution supported from studies of the peatland archives can provide more enlightened and long-term management strategies, not only for valley peatlands in Idaho, but for Rocky Mountain ecosystems as a whole.

The Idaho Conservation Data Center (CDC) is presently involved in a multi-faceted program directed toward the conservation and restoration of valley peatlands in Idaho (Bursik and Moseley 1992). As a first step toward this goal, we are beginning to fill in gaps in our knowledge of the compositional, structural and functional attributes of Idaho's peatland ecosystems through inventory, research and long-term monitoring. No paleoecological studies of valley peatlands of Idaho have been undertaken to reconstruct *in situ* bog vegetational history as has been done elsewhere (Watts and Winter 1966; Miller and Futyma 1987). This study begins to piece together the late Pleistocene - Holocene puzzle of valley peatland development.

During July, August, and September, 1992, paleoenvironmental sampling took place at Hager Lake, Bonner County, Idaho, and Huff Lake, Pend Oreille County, Washington. Sampling was done under the direction of Peter Mehringer, Washington State University (WSU). Field assistants included faculty and graduate and undergraduate students from the WSU Archeology Field Camp, CDC ecologists, a USFS Intermountain Research Station botanist, and USFS Idaho Panhandle National Forest personnel.

METHODS AND RESULTS

Multiple, 10-cm diameter piston cores were collected in plastic core barrels from fen and bog surfaces, and from a raft over the deepest area of Hager Lake (ca. 12.2 m in depth). Frozen sections of the mud-water interface were also collected from deep water at Hager Pond; these remain in frozen storage. The plastic core barrels were sawed to the length of sediment recovery, capped, sealed, and returned to cold storage at the Department of Anthropology, Washington State University.

Upon finding that most sediments in the upper one-half of the cores were soft and wet and that they deformed and dried rapidly upon exposure, Mehringer decided to leave most core barrels uncut and capped to guarantee their integrity until they are sampled. Enough cores were opened, however, to assure that complete sections of the bog and lake sediments are on hand. Sediments were exposed by cutting the barrels lengthwise and removing one-half of the barrel. Thus, the cores were protected during transport and not distorted by extrusion or by splitting.

Several distinct volcanic ashes were observed in the opened cores and in mixed deposits adhering to core barrels. Though none of these tephras has been identified, based on relative position and thickness they are referred to in this report by their most probable source and

age: Mount St. Helens A.D. 1980, Mount St. Helens T (A.D. 1800, Mount Mazama (6850 B.P.), "tawny" unknown tephra (10,600 B.P.), and Glacier Peak (11,250 B.P.). Following is a general narrative of what was found at the five core localities at Hager and Huff lakes. See Appendix 1 for a detailed log of these cores; the core logs will be expanded as work begins on analyzing particular sections. All cores are in cold storage facilities at the Department of Anthropology, Washington State University, Pullman.

Hager Lake - Core Locality 1

We first cored on the floating mat ca. 12 m south of its abrupt edge with open water. Because the coarse fibrous peat was difficult to core, we pushed the core barrel through four or five meters of floating mat and the water column below until lake sediment could be detected. From this point we collected a single core from ca. 9.2 to 11.9 m depth.

The 2.7 meter core was opened and logged; it began in Mazama tephra and organic lake deposits, and extended into blue gray clays at its base. A couplet of Glacier Peak ash at ca. 10.85 m was especially significant because earlier researchers had not found this tephra. They therefore concluded that the depression of Hager Lake became ice free and began collecting sediments only 10,500^{14}C years ago (Mack *et al.* 1978). Deposits representing another 1000 to 1500 years lie below those previously analyzed. These contain records of the first organisms to arrive after deglaciation.

Sediments of this first core offered another important clue to bog history. Peaty deposits that formed after the fall of Glacier Peak tephra suggest a short period of very shallow water (10,000-9,000 B.P. or so) that by itself would have influenced the early success of shallow water and fringe invaders and development of bog and fen communities. In other words, climate-caused changes in the water table have, since earliest time, interrupted and influenced the direction and pace of biological developments.

Hager Lake - Core Locality 2

The second core was taken from a raft near the center of Hager Lake in its deepest area. Before coring, however, we collected frozen sections to provide detailed records of lake history in the recent past. The first section of about 40 cm contained the mud-water interface and two volcanic ashes that we assume to be Mount St. Helens 1980 and Mount St. Helens T (A.D. 1800). The second frozen slab overlaps the first, holds the lower tephra, and extends the frozen section to ca. 60 cm.

Four overlapping cores of 1.8, 2.4, 2.5, and 2.6 m lengths give a complete coverage from just above the mud-water interface (ca. 12.10 m) through 5.3 m of lake deposits to clays at 17.4 m. Several layers of clean and mixed Mazama tephra occur around 15.6 m depth, suggesting sinking and mixing of this tephra in soft lake sediments.

Though the cores penetrated into tough clayey sediments, Glacier Peak tephra was not seen in the deepest core and must lie below what we were able to obtain at this locality. Judging from the sedimentary sequence, the older Glacier Peak-bearing cores from Core Locality 1 overlaps the basal core from Core Locality 2. These two localities together give a complete record of 12,000 years or so from beneath open water.

Hager Lake - Core Locality 3

To obtain as long a record as possible of bog and fen deposits that lie beneath the present *Sphagnum* mat Locality 3 was selected from near the bog edge, adjacent to *Spiraea* and *Kalmia* communities southeast of the pond. To avoid compression of these exceedingly fibrous deposits the upper 1.1 m was taken by cutting the peat with sharpened tiling spades as a sharpened 15 cm diameter plastic pipe was being pushed into the deposits.

Six additional cores of 1.16, 1.37, 1.38, 2.39, 2.5, and 2.67 m lengths give nearly complete coverage from the bog surface through 11.4 m of organic deposits with abundant and well preserved macrofossils. Though Mazama tephra was present, Glacier Peak tephra was not seen in the deepest core and must lie below what we were able to obtain at this locality. Judging from the sedimentary sequence, the older, Glacier Peak-bearing core from Core Locality 1 overlaps the basal core from Core Locality 3.

Hager Lake - Core Locality 4

Locality four was selected to give a continuous record from the sub-basin northwest of Hager Lake. Here we collected overlapping cores through peat and basal clay into gravel (till). We tested three different areas hoping to locate the deepest part of the depression but came far short of the 7 m reported by Rumely (1956). Our deepest core, with overlapping drives of 0.7, 1.21, and 1.83 m, encountered till at 2.66 m. These cores have not been opened, however, judging from resistance encountered at ca. 1.5 m and tephra adhering to the core barrel near 2.6 m, both Mazama and Glacier Peak tephras are probably present.

Huff Lake

We cored the south end of the Huff Lake depression from the bog surface about 10 m south of its abrupt edge with open water. Because the peat was coarse and fibrous we excavated two peat blocks from the upper 50 cm and began coring in the open holes. Eight drives in two cores (1.85, 2.27, 2.45 and 2.83 m long, and 1.78, 2.25, 2.73, and 2.97 m long) gave a completely overlapping sequence from 0.5 to ca. 10.8 m depth. We recovered both Mazama and Glacier Peak tephra, and perhaps a different tawny-colored volcanic ash just 10 cm above the light gray Glacier Peak tephra.

Describing deposits of the three deepest drives revealed that some sediments in the two meters above the "tawny" tephra had been mixed and that intact beds had been tilted. The chaotic condition of these deposits could have resulted from a debris flow entering the

depression in its narrow, steep-sided southern end near the coring site. Perhaps deposits of the Huff Lake basin at its widest point in the area of the present deepest open water (ca. 5.5 m) would have been far enough from a steep slope to have escaped disturbance.

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APPENDIX 1

Core logs from Hager and Huff lakes, Idaho Panhandle National Forest.

CORE LOGS

HAGER POND, IDAHO

Core Locality I -- Floating Mat
Locality 1, Core 1, Drive 1
9.20 - 11.90 m

11.90 - 11.10 m
[1]Massive clay unit of uniform texture, 5Y 4/3 olive (oxidized), 5GY 5/1 greenish gray (unoxidized), and 5Y 7/1 light gray (dry). The unit breaks along irregular surfaces. Darker band between 11.81 and 11.83 m a occurs, 5Y 3/2 dark olive gray (oxidized), 2.5Y 2/0 black (unoxidized), and 5Y 6/1 gray (dry). 3 mm wavy layer of volcanic ash at 11.39 m Darker silt sized tephra, 5Y 5/1 gray (unoxidized and oxidized) and 2.5Y 7/0 light gray (dry), occurs as a basal 2 mm band with an overlying 1 mm band of finer material, 5Y 7/2 light gray (unoxidized and oxidized) and 10 YR 8/1 white (dry). Another 3 mm layer of volcanic ash at 11.33 m has a 2 mm thick basal unit consisting of fine sand sized phenocrysts, 5Y 3/1 very dark gray (unoxidized and oxidized) and 2.5Y 5/0 gray (dry). The upper 1 mm of this tephra layer consists of finer silt sized material 5Y 7/1 light gray (unoxidized and oxidized) and 10YR 8/1 white (dry). Sharp upper and lower contacts between ash and sediments. Vivianite crystals [$Fe_3(PO_4)_2 \cdot 8H_2O$], of light gray changing to blue on oxidation, occur sporadically throughout the unit.

11.10 - 11.08 m
Massive organic clay, 5Y 2.5/2 black (unoxidized and oxidized) and 5Y 5/1 gray (dry). Sharp upper boundary.

11.08 - 10.88 m
Massive clayey peat, 10YR 2/1 black (unoxidized and oxidized) and 5Y 2.5/2 black (dry). Macrofossils abundant in the lower portion of unit. Sharp upper and lower contacts . Vivianite occurs sporadically throughout.

10.88 - 10.31 m
Massive organic clay, 5Y 3/1 very dark gray (unoxidized and oxidized) 5Y 6/1 gray (dry). The unit grades to a darker color 5Y 2.5/1 black (unoxidized and oxidized) and 5Y 6/2 olive gray (dry) by 10.50 m, then returns to previous color. Light colored bands 5Y 5/1 gray (unoxidized), 5Y 4/2 light gray (oxidized), and 5Y 7/1 light gray (dry) occur at 10.840-10.843, 10.498-10.500, 10.420-10.447, and 10.370-10.380. Sharp upper boundary.

[1]In describing the sediments, color was determined with Munsell Color Charts. Bands differ primarily in color whereas laminae (layers) differ in texture or content.

10.31 - 9.57 m
Massive clayey gyttja grading into clayey, silty gyttja to 9.66 m then returning to clayey gyttja above, 5Y 2.5/2 black (unoxidized), 5Y 2.5/1 black (oxidized), and 5Y 6/2 light olive gray (dry). A 7 mm layer of volcanic ash, 7.5YR 6/2 pinkish gray (unoxidized, oxidized, and dry), at 9.581 to 9.587 m. Sharp upper boundary.

9.57 - 9.32 m
Massive silt to fine sand sized tephra, 7.5YR 6/2 pinkish gray (unoxidized, oxidized, and dry) in color. The upper portion, near the top of the barrel, appears mixed.

Core Locality II -- Deep Water
Locality 2, Core 1, Drive 2
17.40-14.86 m

17.40 - 17.05 m
Organic clay, 5Y 2.5/2 black (unoxidized), 5Y 3/1 very dark gray (oxidized), and 5Y 5/1 gray (dry). lighter colored laminae 5Y 4/2 olive gray (unoxidized and oxidized), and 5Y 6/1 light gray (dry), < 1 mm occur throughout the section. Sharp upper boundary.

17.05 - 16.78 m
Organic rich peaty clay with darker areas, 5Y 2.5/1 black (unoxidized and oxidized) and 5Y 4/1 dark gray (dry), occurring at 17.05-16.96, 16.92-16.87, and 16.84-16.79. Lighter areas, 5Y 2.5/2 black (unoxidized and oxidized) and 5Y 5/2 olive gray (dry), occur between 16.96-16.92 and 16.87-16.84. Vivianite present throughout, but concentrated in darker sediments. Peaty, macrofossil rich layer at 16.98 m. Sharp upper boundary.

16.78 - 16.54 m
Organic rich clay, 5Y 2.5/1 black (unoxidized), 5Y 3/2 dark olive gray (oxidized) and 5Y 6/1 gray (dry). A darker area, 5Y 2.5/1 black (unoxidized and oxidized) and 5Y 5/2 olive gray (dry), with light laminae, 5Y 4/2 olive gray (unoxidized and oxidized) and 5Y 6/1 gray (dry), from 10.67-10.61; Vivianite concentrated in this section. Sharp upper boundary.

16.54 - 16.53 m
Light colored clay, 5Y 4/1 dark gray (unoxidized) 5Y 4/2 olive gray (oxidized) and 5Y 7/1 light gray (dry), grading upward to, 5Y 3/2 dark olive gray (unoxidized), 5Y 3/1 very dark gray (oxidized), and 5Y 6/1 gray (dry). Sharp upper boundary.

16.53 - 15.72 m
Massive, silty clay gyttja, 5Y 2.5/2 black (unoxidized) 5Y 2.5/1 black (oxidized) and 5Y 5/1 gray (dry). Lighter colored laminae < 1 mm, 5Y 3/2 dark olive gray (unoxidized and oxidized) and 5Y 6/1 light gray (dry), occur throughout. Sharp upper boundary.

15.72 - 15.25 m
Organic rich gyttja, 5Y 2.5/1 black (unoxidized and oxidized) and 5Y 3/2 dark olive gray (dry) in color. Micro-laminae <1 mm, 5Y 4/2 olive gray (unoxidized and oxidized) and 5Y 4/2 olive gray (dry), occur throughout. Vivianite concentrations occur throughout. Tephra layer at 15.70-15.71 m, and as discontinuous pockets at 15.69-15.64, and 15.55-15.58 m. Tephra is silt sized, 2.5Y 5/2 grayish brown (unoxidized and oxidized) and 10YR 7/1 light gray (dry). No apparent sorting within tephra layers.

15.25 - 14.84 m
Massive peaty gyttja with abundant macrofossils, 10YR 2/2 very dark brown (unoxidized), 5Y 2.5/1 black (oxidized) and 10YR 2/1 black (dry). Layers with heavy concentrations of macrofossils occur between 15.22-15.15 and 15.11-15.02 m. Sharp upper boundary..

Unopened Cores
Locality 2, Core 1, Drive 1, 12.40 - 14.86 m
Locality 2, Core 2, Drive 1, 13.50 - 16.13 m
Locality 2, Core 3, Drive 1, 12.08 - 14.00 m

Frozen Sections of lake bottom and mud-water interface

Frozen Section #2, Front Face #1
This frozen section is approximately 46 x 33 cm. Two tephras are obvious; the upper tephra is 12 cm from the top. It is approximately 1 cm thick and appears to be sorted with finer (silt sized) tephra at the base, set upon an undulating surface, and at the top. Larger sized material separates the finer material. The second tephra occurs 37 cm from the top as a discontinuous 2 mm thick band. Its base is undulating. No colors were taken due to the necessity to keep the material frozen.

Frozen Section #2, Side #1
This section is 34 x 10 cm; it contains the same dark colored organic sediment with two tephras. The upper tephra is 17 cm from the top. It is approximately 5 mm thick and exhibits the sorting characteristic on the front face. The second tephra is 2-4 mm thick and occurs 30 cm from the top. It is discontinuous and appears somewhat mixed.

Frozen Section #2, Side #2
This piece is 26 x 9 cm it is dark colored organic sediments with two tephras. The upper tephra at 2 cm is 2-4 cm thick. The lower tephra is at 22 cm and its thickness is < 1 mm.

Frozen Section #1, Face #1
In this 36 x 33 cm section a discontinuous tephra layer occurs approximately 5 cm from the top. The band is 2-4 mm wide and appears discontinuous. The tephra is more similar to the lower tephra of section 2 than to the upper tephra and appears slightly mixed.

Frozen Section #1, Face #2
This section, from the backside of the freezer of the first frozen section, is 12 x 26 cm. The upper tephra is ~10 cm from the top. It occurs as discontinuous stringers occurring within a zone. The lower tephra is undetectable.

Core locality III -- Bog Edge (Fen 2)
Locality 3, Core 2, Drive 2,
6.31-8.98 m

8.98 - 8.49 m
Clayey silty gyttja, massive, 10YR 2/2 very dark brown (unoxidized), 10YR 2/1 black (oxidized), and 5Y 2.5/2 black (dry). Amount of silt decreases upward The upper boundary is defined where mixing between sediment and volcanic ash begins. Sharp upper boundary

8.49 - 7.94 m
Zone of mixed volcanic ash in sediments of clayey gyttja grading to fibrous peaty gyttja with abundant macrofossils; basal clayey gyttja is 10YR 2/1 black (unoxidized and oxidized) and 5Y 2.5/1 (dry). The upper fibrous peaty gyttja is 10YR 2/1 black (unoxidized and oxidized) and 5Y 3/2 dark olive gray (dry) in color. Volcanic ash occurs as stringers and pockets throughout the unit; it varies from fine sand to silt size clasts with some sorting evident. Tephra varies from 10YR 6/1 light gray (unoxidized and oxidized) and 10YR 8/1 white (dry) to 7.5YR 6/2 pinkish gray (unoxidized and oxidized) and 5YR 8/1 white (dry). These may not be primary tephra deposits. Sharp upper boundary.

7.94 - 6.31 m
Massive fibrous peaty gyttja with macrofossils throughout, 7.5YR 3/2 (unoxidized), 10YR 2/1 (oxidized), and 5Y 4/2 olive gray (dry) in color. Fibrous component is dominated by small rootlets. Branch with 6-7 annual rings occurs 7.50 m. Less fibrous zone of gelatinous gyttja at 7.02-7.25 m.

Locality 3 (Fen 2), Core 2, Drive 2
6.30 - 3.80 m
Entire core consists of undifferentiated macrofossil rich, gelatinous gyttja, 7.5YR 3/2 (unoxidized), 10YR 2/1 black (oxidized), and 5Y 4/2 olive gray (dry). The macrofossils, including rootlets lend body to the material, and are spread evenly throughout the core.

Locality 3 (Fen 2), Core 2, Drive 3
11.40 - 8.98 m

11.40 - 11.29 m
Organic rich clay, 5Y 2.5/2 black (unoxidized), 5Y 2.5/1 black (oxidized), and 5Y 2.5/2 black (dry) in color. The material contains streaks of charcoal and occasional more silty sized layers. Sharp upper boundary.

11.29 - 10.71 m
Massive clayey fibrous peat with some obvious macrofossils, 10YR 2/1 black (unoxidized and oxidized), and 5Y 5/1 gray (dry). Sharp upper boundary.

9.70 - 9.47 m
Organic clay, massive, 5Y 3/2 dark olive gray (unoxidized), 5Y 2.5/2 black (oxidized), and 5Y 6/1 gray (dry); bands of lighter color with sharp boundaries, 5Y 4/1 dark gray (unoxidized and oxidized) and 5Y 7/1 light gray (dry), from 9.87 to 9.89 m. Sharp upper boundary.

9.47 - 9.01 m
Organic clayey gyttja, massive, 5Y 2.5/2 black (unoxidized), 5Y 2.5/1 black (oxidized), and 5Y 5/1 gray (dry), with slight color variation.

Unopened Cores (Fen 3)
Locality 3, Core 1, Drive 1, 0.00 - 1.12 m (15 cm diameter bog top section)
Locality 3, Core 1, Drive 2, 1.28 - 2.49 m
Locality 3, Core 1, Drive 3, 2.50 - 3.87 m
Locality 3, Core 1, Drive 4, 3.87 - 5.25 m

Core Locality IV - Fen North of Hager Pond
Unopened cores
Locality 1, Core 1, Drive 1, 1.20-2.12 m
Locality 2, Core 1, Drive 1, 0.88-1.58 m
Locality 3, Core 1, Drive 1, 0.70-2.53 m
Locality 3, Core 1, Drive 2, 2.53-2.73 m
Locality 3, Core 2, Drive 1, 1.45-2.66 m

HUFF LAKE, WASHINGTON

Locality 1, Core 1, Drive 4
9.95-7.20 m

9.95-9.77
Very fine sandy silt fining upwards, 5BG 4/1 dark greenish gray (unoxidized), 5GY 5/1 greenish gray (oxidized), and 5Y 6/1 light gray (dry). Dark organic fragments throughout. Diffuse upper boundary.

9.77-9.58
Massive clay, 5BG 5/1 greenish gray (unoxidized), 5GY 5/1 greenish gray (oxidized) and 5Y 7/1 light gray (dry) becoming somewhat lighter toward top. Sharp upper boundary.

9.58-8.97
Organic clayey gyttja, 5Y 3/1 very dark gray (unoxidized), 5Y 4/1 dark gray (oxidized), and 2.5Y 5/2 grayish brown (dry). Top of unit exhibits a darker zone, 5Y 2.5/2 black (unoxidized and oxidized) and 5Y 3/2 dark olive gray (dry), of organic gyttja from 9.00-8.98 m. Band of massive clay from 9.35-9.38 m, 5GY 4/1 dark greenish gray (unoxidized), 5GY 5/1 greenish gray (oxidized), and 5Y 7/1 light gray (dry). There are three distinct tephra layers. The basal silt-sized tephra is 5 mm thick (9.190-9.195), 5Y 6/1 light gray (unoxidized and oxidized) and 5YR 8/1 white (dry); sorting is evident with darker phenocrysts towards the base. This ash appears to have fallen upon an uneven surface. The second 6 mm thick tephra (9.152-9.158 m) is fine sand to silt sized individual dark colored phenocrysts. Larger grained white pumiceous material and the darker phenocrysts occur in a fine grained, light colored, silt sized matrix. The overall color is 5Y 6/1 gray (unoxidized and oxidized) and 5YR 8/1 white (dry). Composition of grain sizes suggest sorting during deposition on an uneven, irregular surface. The third, uppermost, silt sized tephra, 10YR 5/2 grayish brown (unoxidized and oxidized) and 5YR 8/1 white (dry) in color., occurs as a discontinuous band between 9.05 and 9.10 m. Diffuse upper boundary.

8.97-8.88
Organic, peaty gyttja with numerous macrofossils, 5Y 2.5/1 black (unoxidized and oxidized) and 5Y 4/1 dark gray (dry) in color. Sharp upper boundary.

8.88-8.33
Organic gyttja, 10YR 2/2 dark brown (unoxidized), 5Y 2.5/1 black (oxidized), and 5Y 4/2 olive gray (dry). This unit consists of a zone of tephra layers in sediment and a zone of mixed tephra and sediment. The layers of tephra and sediment are separate from 8.54 to 8.36 where rounded gyttja clasts, to 2 x 3 cm, are mixed with ash and sediment. Intervening tephra layers are silt to fine sand sized, 10YR 5/1 gray (unoxidized and oxidized) and 10YR 7/1 light gray (dry), and show sorting. Sharp upper boundary.

8.33-7.07 m
Homogeneous gelatinous gyttja, 5Y 2.5/2 black (unoxidized), 5Y 2.5/1 black (oxidized), and 10YR 4/2 dark grayish brown (dry) in color. Horizontal bedding, defined by slight variations in colored laminae between 1-2 cm thick, is evident to 7.56 m where severely tilted beds occur. Silt sized tephra layers, 10YR 7/1 light gray (unoxidized and oxidized) and 10YR 8/1 white (dry), 4 mm thick, at 7.56 and 7.51 m have discontinuous stringers emanating from them. At 7.23 m another, silt sized, 5 cm thick tephra layer, 10YR 7/1 light gray (unoxidized and oxidized) and 10YR 8/1 white (dry). Bedding returns to horizontal above this layer.

Locality 1, Core 1, Drive 3
4.80-7.20 m

7.20-6.62 m
Gelatinous gyttja with macrofossils throughout, 5Y 2/1 very dark grayish brown (unoxidized), 5Y 3/2 dark olive gray (oxidized), and 10YR 7/2 light gray (dry) in color. Minor color variations define horizontal bedding. A layer of silt to clay sized sediment, 5Y 3/1 very dark gray (unoxidized), 5Y 2.5/2 black (oxidized), and 10YR 6/1 gray (dry) from 6.88-6.85 m. Sharp upper boundary.

6.62-4.81 m
gelatinous gyttja differentiated by varying concentrations of macrofossils and minor color variations, 10YR 3/3 dark brown (unoxidized), 5Y 2.5/2 black (oxidized), and 10YR 5/2 grayish brown (dry). Macrofossils rich layers occur at 6.28-6.29, 6.050-6.055, 5.82-5.86, and 5.04-5.16 m. Possible ash layer at 5.02 m, is interspersed as a discontinuous band < 1 mm thick.

Locality 1, Core 2, Drive 4
10.76-8.71 m

10.76-10.02 m
Layers, > 5 cm of very fine sand and silt grading upward to massive clays, 5GY 5/1 greenish gray (unoxidized), 5GY 6/1 greenish gray (oxidized), and 5Y 7/1 light gray (dry). Diffuse upper boundary.

10.02-9.66 m
Massive clay, 5GY 4/1 dark greenish gray (unoxidized), 5Y 5/1 gray (oxidized), and 5Y 7/1 light gray (dry) in color. Sharp upper boundary.

9.66-9.42 m
Organic clayey gyttja, 5Y 3/1 very dark gray (unoxidized and oxidized) and 5Y 4/2 olive gray (dry) in color. Massive clay band from 9.63-9.65, 5Y 5/1 gray (unoxidized), 5Y 4/1 dark gray (oxidized), and 5Y 7/1 light gray (dry) in color. Three volcanic ashes are present. Basal tephra (9.570-9.575), 5 mm thick, silt sized tephra, 5Y 6/1 light gray (unoxidized and oxidized) and 5Y 8/1 white (dry) appears to have fallen upon an uneven surface. Small pockets of tephra at 9.55 m, 5Y 6/1 gray (unoxidized and

oxidized) and 5Y 8/1 white (dry), consist of white pumiceous fragments and darker phenocrysts; mixed with this tephra and occurring slightly above is a silt sized deposit resembling mixed volcanic ashes up core, 10YR 5/1 gray (unoxidized and oxidized) and 10YR 8/1 white (dry) in color. Silt sized layer, $\leq$ 1 mm, at 9.45 m, 10YR 5/2 grayish brown (unoxidized and oxidized) and 5YR 8/1 white (dry). Sharp upper boundary.

9.42-8.76 m
This unit consists of a zone of mixed volcanic ash and clayey gyttja. Layers of sediment occur interspersed with tephra to 9.01 m where they become mixed. The mixed portion contains a tephra and sediment matrix with rounded sediment clasts. The largest clast is 2 x 4 cm. Gyttja, 10YR 2/2 very dark brown (unoxidized), 5Y 2.5/1 black (oxidized), and 5Y 4/1 dark gray (dry). Intervening ash bands are silt to fine sand sized, 10YR 5/1 gray (unoxidized and oxidized) and 10YR 8/1 white (dry) in color. Tephra layers at 9.40-9.39, 9.35-9.32, 9.26-9.24, 9.22-9.18, and 9.14-9.10 m. Mixed zone at 9.01-8.76 m.

Locality 1, Core 2, Drive 3
6.75 - 8.55

8.55-7.32 m
The sediment in this unit is interspersed with volcanic ash. The sediment consists of organic gelatinous gyttja, 2.5Y 3/2 very dark grayish brown (unoxidized), 5Y 2.5/2 black (oxidized), and 5Y 5/3 olive (dry). Horizontal beds are defined by slight variations in color up to 7.88 m. From 7.79-7.39 m beds dip steeply (>45 degrees) then return to horizontal. Silt sized tephra, 10YR 6/2 light brownish gray (unoxidized and oxidized) and 10YR 8/1 white (dry), occurs in layers throughout the core. deepest layer at 8.44-8.49 is mixed with rounded gyttja clasts to 1 x 2 cm. Other tephra layers at 8.30, 8.26-8.25, 8.14-8.11, 7.88-7.79, 7.65, and 7.39-7.32 m. Sharp upper boundary

7.32-6.74
Gelatinous gyttja with abundant macro-fossils, 2.5Y 3/2 very dark grayish brown (unoxidized and oxidized) and 5Y 6/2 light olive gray (dry). Slight variations in color define horizontal bedding throughout. A darker band of clay to silt sized material, 5Y 2.5/1 (unoxidized and oxidized) and 10YR 5/1 gray (dry), between 7.05 and 7.07 m.

<u>Unopened Huff Lake Cores</u>
Locality 1, Core 1, Drive 1, 0.49 - 2.35 m
Locality 1, Core I, Drive 2, 2.35 - 4.80 m
Locality 1, Core 2, Drive 1, 1.07 - 3.91 m
Locality 1, Core 2, Drive 2, 3.90 - 6.77 m